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Effects of Different Water Regimes and Poultry Manure on Growth, Development and Yield of Hot Pepper (*Capsicum annum* L.)

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Abstract

Pot experiment was conducted during the wet period of (June to September 2012) in a screen house at the Forest and Horticultural Crops Research Centre (FOHCREC), Kade of the University of Ghana. The experiment evaluated the effect of water regime and poultry manure on growth and development, physiological activities and yield of hot pepper (*C. annum* L.). Five watering/ stress regimes (250mL, 500mL, 1000mL, 1500mL and 2000mL) and four rates of poultry manure (0, 10, 15 and 20 t/ha) applications were adopted in this study. The experiment was designed as a factorial in CRD and laid out in split-plots with three replications. Data collected included plant height, leaf number, shoot fresh and dry weight, shoot/root ratio, leaf area, net assimilation rate, relative growth rate, leaf weight ratio, number of flowers per plant, fruit number and fruit weights per plant. All data collected were analyzed using the analysis of variance (ANOVA) and significant means were separated at p= 0.05 (Tukey's HSD). Results showed that there was significant effect of irrigation levels on biometric parameters such as plant height, fresh weight, stem diameter, branches number, number of leaves, leaf area per plant in combination with poultry manure treatments and interaction effect.

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The study also showed significant effect of irrigation levels on secondary response variables such as relative growth rate, net assimilation rate, leaf area ratio, specific leaf area and leaf weight ratio as well as yield and its components in combination with poultry manure treatments. Interaction effect of poultry manure and irrigation levels was significant. The study indicated that organic matter increased with the application of poultry manure which also improved the soil physical and chemical properties including ph, exchangeable cations. Poultry manure at higher rates (15-20t/ha) and in combination with irrigation levels at 1000 – 1500mls increased plant height, number of leaves, shoot fresh and dry weights as well as total plant dry weight and leaf area. At low water levels plant growth was reduced. The study further revealed that poultry manure at 15t/ha and irrigation levels of 1000 -1500mls increased yield and low levels of poultry manure and water applications resulted in low yields. Proline content in pepper plants were found to be higher at low water stress and poultry manure levels.

Key words: Legon 18 pepper; Poultry manure; Irrigation regimes/scheduling.

1. Introduction

Hot pepper **(*Capsicum annum* L.)** is one of the distinguished crops of genus *Capsicum.* Other are sweet pepper, bird eye pepper and aromatic pepper [25]. Hot pepper or chili group is the world's second most important vegetable crop after tomatoes in terms of quantity of production [56]. Peppers are estimated to be grown on over 1.7 million hectares (ha) worldwide [20]. The main chili peppers producers in the world are China, Turkey, Nigeria, and Mexico, which in total account for more than 70 percent of the world chili pepper production [51]. Pepper is believed to have been introduced into West Africa by the Portuguese traders during the 15^{th} Century [41]. It is used as a condiment or spice for seasoning and stimulating appetite, as well as used in local medicine especially for herbal practitioners who prepare ointments for rheumatism and joint pains. Around the world it is eaten by at least one out of four persons, making it the most used spice after salt [47].

Pepper is one of the principal vegetable crops for export in Ghana. As its production is a good basis of income for small producers or out-growers and is significantly one of the foreign exchange earning vegetable crops [11]. Hot pepper is also an important vegetable crop in Liberia and source of livelihood for thousands of farm households in the country. Production of the crop, however, is beset with several challenges, amongst which are availability of water and little know-how in the use of nutrients to optimize yield.

Water shortage in soil may affect nutrient availability and absorption by plant roots. Therefore, the combined improvement of water and nutrient use efficiencies under conditions of locally restricted irrigation should be an important research topic [27]. Hot pepper is grown extensively under rainfed conditions and high yields are obtained with rainfalls of 600 to 1250 mm, well distributed over the growing season [17, 50]. In the semi-arid and arid regions, production however, depends on irrigation because of unreliability of rainfall, both in terms of quantity and distribution [54]. In Ghana, one of the major setbacks in vegetable production is scarcity of water during the dry season and the incapacity of farmers to determine the accurate amount of water and fertilizer required during the growing season. Thus, the amount and distribution required for plants like pepper has not been well studied and calls for further investigation on the effect of water regimes on pepper growth.

The use of soil organic amendments, which involves the application of organic manures such as poultry manure, goat manure, cow dung, farm yard manure, green manure, crop stubble and composted agro-industrial wastes to soil has been documented and appreciated as another effective method of improving the yield of hot pepper [13].

Poultry manure is one of the main sources of organic plant nutrient and has a great potential for soil fertility maintenance, and equally important are its effects on the improvement of soil organic matter, soil structure and the biological life of the soil when applied in adequate quantities [32].

Currently, vegetable crop farmers are beginning to realize and appreciate the fertilizing value of this source of nutrients and are making good use of it [38].

Irrigation and fertilization are reported to be intrinsically linked. However, up to date literature is lacking on the effects of different fertilization programmes and poultry manure or their interactions on pepper growth and yield performances.

In addition, the understanding of the physiological characters and their effects on pepper yield has not been well documented.

The objectives of the study were therefore to i) determine the effect of different rates of poultry manure and water stress regimes on growth and development, physiological activities, proline activity and yield of hot pepper and ii) determine the optimum rate of poultry manure in combination with the best water regime for optimum yield of hot pepper.

2. Materials And methods

2.1. Study area

The study was carried out from June to September 2013 in a screen house at the Forest and Horticultural Crops Research Centre (FOHCREC), Kade, which lies on latitude $6^0$09'and $6^0$06'N and longitude $0^0$55'and $0^0$49'W and 135.9 m above sea level. The centre is located in the semi-deciduous forest agro-ecological zone of Ghana in the Kwaebibrim district of the Eastern Region.

2.2. Climatic condition of experimental area

The study area is characterized by a bi-modal rainfall pattern (in June and October and a brief dry spell in August and a dry season from December to March). The annual rainfall amount ranges between 1300-1800mm. Temperature ranges between 25-38^0C [34, 37] .

During the period of the experiment, temperatures readings ranged from 30.0^0C to 35.1^0C (Table 1). A portable solar thermometer was used for temperature readings. Readings were done in the morning and afternoon.

Table 1: Mean temperature (^{0}C) during the experimental period

	Temperature	
Month, Year	Maximum	Minimum
August, 2012	35.1	25.8
September, 2012	30.9	28.6
October, 2012	29.3	26.2
November, 2012	32.9	30.0

Source: Forest and Horticultural Crop Research Centre (FOHCREC)

2.3. Data collection And analysis

Destructive sampling was done during the vegetative and fruiting stages in order to measure various responses of the plants to water regime and the soil fertility treatments. Samples were used for the determinations of leaf chlorophyll content, proline activity, leaf, stem and root fresh and dry weight, total plant dry weight, shoot to root ratio, relative water content, net assimilation rate, relative growth weight, leaf weight ratio, leaf area. The roots of the plant were carefully washed to enable the surrounding soil to be easily removed. All data collected were analyzed using the Analysis of Variance (ANOVA) and significant means were separated at alpha 0.05 (Tukey's HSD). Genstat version 9.2 statistical software [23] was used to analyze the data.

3. Results

3.1. Physical and chemical properties of soil amended with different rates of poultry manure

Analysis of the poultry manure used for the experiment was found to contain 0.99, 1.41 and 1.57% total nitrogen, phosphorus and potassium, respectively.

3.2. Changes in soil physical and chemical properties due to poultry manure applications

The results in Table 2 indicate that the soil composition was 42.6% sand, 29.9% silt and 27.5% clay. Chemical analyses showed the following soil characteristics; - pH-5.1; organic carbon – 1.53%; total nitrogen – 0.13%, total- P 262.5ppm; total K -0.09%; extractable Ca and Mg of 2.4 and 0.8mgkg^{-1} respectively while the CEC was found to be 14.3cmolkg^{-1} (Table 3).

Changes were observed with the addition of poultry manure to the soil (Table 3). Organic carbon increased with increased rate of poultry manure (PM). 20t/ha PM supplemented soil gave the highest organic carbon (1.98) content. Similar increases were observed in available P, K, extractable Ca and Mg (Table 3). Available K increased from 0.61mgkg-1 in the control to 1.37mgkg-1 in the 20t/ha PM treatment amended soil while available P also increased from 10.18 in the control to 19.5mgkg-1 in the 20t/ha PM treatment. Exchangeable Ca^{2+} and Mg^{2+} increased from 2.4 and 0.8mgkg-1 in the control plots (soil only) to 4.2 and 1.4mgkg-1 in the 20t/ha PM treated soils. Table 4 again indicated that the control (soil only) recorded a pH of 5.1 while a PH of 5.3, 5.6 and 5.4 were recorded in the 10, 15 and 20t/ha PM amended treatments respectively. The texture class of the experimental soil was clay loam at the field capacity and permanent wilting point of 30.3% and 14.4% respectively.

Table 2: Physical and chemical composition of soil amended with different rates of poultry manure 2 weeks after transplanting (2WAT)

Physical and chemical composition	Soil (Control)	Poultry manure (t/ha)		
		10	15	20
Sand (%)	42.58	42.95	41.95	42.8
Silk (%)	29.92	30.05	30.55	30.2
Clay (%)	27.5	27	27.5	27.0
Organic carbon (%)	1.53	1.84	1.91	1.98
Kj Nitrogen (%)	0.13	0.15	0.15	0.17
Total P (ppm)	262.5	385.2	427.1	467.5
Total K (%)	0.09	0.12	0.15	0.16
Available K (mg kg^{-1})	0.61	0.83	1.21	1.37
Available P (mg kg^{-1})	10.18	17.96	18.08	19.46
Water Holding Capacity	75	70	70	70
Ca^{2+} (mg kg^{-1})	2.4	2.8	3.6	4.2
Mg^{2+}(mg kg^{-1})	0.8	1.2	1.2	1.4
Cation Exchange Capacity [Cmol/kg]	14.3	16.7	16.8	17.1
pH 1:1 H_2O	5.1	5.3	5.6	5.4
Bulk Density	1.4	1.3	1.3	1.3

Source: University Laboratory Soil Science Analysis Laboratory

3.3. Changes in soil characteristics at the end of the cropping cycle (12 WAT)

Table 3 shows the effect of poultry manure application on soil physical and chemical characteristics at 12 weeks after transplanting. Soil pH for all poultry manure amended soil increased (PM10t/ha- = 6.6, PM 15t/ha = 6.7 and PMm20t/ha = 6.8) and bulk density decreased (Pm 10t/ha = 1.3, Pm15t/ha = 1.2 and Pm 20t/ha = 1.2) while Nitrogen-N, available P, available K and organic matter contents increased. The nitrogen content increased from 0.21% in the control plots compared an increase of 0.23, 0.24 and 0.26% in PM at 10, 15 and 20t/ha respectively

(Table 3). Available P increased from 12.44mgkg^{-1} in the control treatment to 82.3, 93.2 and 118.1mgkg^{-1} PM treatments of 10, 15 and 20t/ha respectively. Data in Table 4 again indicate that the CEC increased with increased rates of poultry manure application to the soil. It increased from 16.02 in the control plot to 16.92, 17.04 and 17.16 at PM rates of 10. 15 and 20t/ha plots. With regards to bulk density, there was a decrease from 1.3 in the control to 1.2 at PM rates of 15 and 20t/ha respectively (Table 3).

Table 3: Physical and chemical composition of soil amended with different rates of poultry manure 12 weeks after transplanting (12WAT)

Physical and chemical composition	Soil (Control)	Poultry manure (t/ha)		
		10	15	20
Sand (%)	41.96	42.10	41.36	41.71
Silt (%)	30.54	30.4	33.64	33.29
Clay (%)	27.5	27.5	25.0	25.0
Organic carbon (%)	1.95	2.64	2.84	2.98
Kj Nitrogen (%)	0.21	0.23	0.23	0.26
Total P (ppm)	284.6	693.2	704.5	1122.4
Total K (%)	0.08	0.11	0.15	0.17
Available K (mg kg $^{-1}$)	0.59	0.78	1.25	1.55
Available P (mg kg $^{-1}$)	12.44	82.3	93.2	118.1
Water Holding Capacity (WHC)	60	70	73	75
Ca^{2+} (mg kg $^{-1}$)	2.4	10.2	11.4	12.2
Mg^{2+}(mg kg $^{-1}$)	1.0	3.8	5.6	6.0
Cation Exchange Capacity (CEC) [Cmol/kg]	16.02	16.92	17.04	17.16
pH	5.5	6.7	6.5	6.8
Bulk Density	1.3	1.3	1.2	1.2

Source: University Laboratory Soil Science Analysis Laboratory

3.4. Effects of different rates of poultry manure on plant height, number of leaf and stem girth

The effect of poultry manure (PM) on biometric parameters such as plant height, leaf number, stem girth, branch number and leaf area were found to vary significantly with the rate of application (Table 4). The results show that the parameters responded differently to the different rates of PM. Plant height significantly increased by 57.6, 67.5 and 77.1% when the rates of PM application increased from 0 in the control to 10, 15 and 20t/ha, respectively (Table 4). The increase in leaf number ranged from 80.4, 88.7 and 111.6% for 10, 15 and 20%, compared to the control. Similarly, stem girth, increased by 65.4, 71.7 and 72.2% as PM increased from 10, 15 and 20t/ha, respectively. Leaf area of the test plants increased by 97.5, 179.8 and 137.1% for PM rates of 10, 15 and 20t/ha compared to the control.

Table 4: Combined effects of poultry manure amended soils and irrigation levels on plant height, leaf number, stem girth, branches number and leaf area of pepper

Poultry manure (t/ha)	Irrigation levels	Plant height (cm)	Leaf number (no/plant)	Stem girth (mm)	Branches number	Leaf area (cm^2)
0	250	30.4	56	1.90	3	13.4
	500	30.8	62	2.11	4	9.91
	1000	33.9	58	1.80	3	9.94
	1500	33.4	70	1.88	4	7.88
	2000	32.9	55	2.04	3	11.2
	Mean	**32.3**	**60.2**	**1.95**	**2.60**	**9.30**
10	250	39.7	93	2.94	5	36.1
	500	50.0	107	3.52	6	14.0
	1000	50.3	96	3.18	5	16.8
	1500	53.9	106	3.12	6	21.0
	2000	60.5	126	4.22	7	26.7
	Mean	**51.0 (57.6)**	**112.2 (80.4)**	**3.4 (65.4)**	**6(66.7)**	**18.3 (97.5)**
15	250	44.5	93	3.04	5	15.5
	500	50.5	115	3.54	6	21.7
	1000	54.3	97	3.58	5	32.3
	1500	58.4	126	3.54	7	19.4
	2000	62.6	136	4.25	7	20.7
	Mean	**54.1(67.6)**	**117.4 (88.7)**	**3.6 (71.7)**	**6.2(72.2)**	**26.0 (179.8)**
20	250	48.1	97	3.42	6	13.4
	500	54.6	131	3.57	7	22.5
	1000	54.6	120	3.61	6	26.3
	1500	62.8	132	3.88	7	18.7
	2000	64.0	156	4.36	8	19.0
	Mean	**57.0 (77.1)**	**127.2 (111.6)**	**3.8 (72.2)**	**7 (169.2)**	**22.0 (137.1)**
PM		**	**	**	*	**
IL		**	**	**	*	ns
PM XIL		**	**	*	*	*

**P<0.01; *P<0.05; ns = Non-significant PM: Poultry manure IL: Irrigation levels.

3.5. Effects of different irrigation levels on biometric parameters

There were significant effect of different irrigation levels on plant height, leaf number, stem girth, branch number and leaf area (Table 5). Among the different levels of treatment 1500ml-2000ml/plant responded the highest in all the PM rates. There was an increase in plant height as the irrigation levels increased. An increase of 14.3, 19.8, 28.1 and 35.2% at 500, 1000, 1500 and 2000ml/plant respectively was observed (Table 5). With regards to leaf number a percentage increase of 22.4, 27.7, 34.8 and 39.5% was observed for 500, 1000, 1500 and 2000ml/plant compared to the least level of 250ml/plant. A significantly percentage change of 10.1, 13.0, 23.2 and 31.6% was observed in stem girth when plants were supplied with 500, 1000, 1500 and 2000mls/plant respectively to the different rates of PM (Table 5). In terms of leaf area, a percentage increase of 37.7, 72.6, 96.0% was observed when water was applied at 500, 1000 and 1500mls/plant in the different soil PM amended rates.

Table 5: Mean effects of different irrigation levels on leaf number stem girth, branches number and leaf area of pepper

Irrigation levels	Plant height (cm)	Leaf number (no/plant)	Stem girth (mm)	Branches number	Leaf area (cm^2)
250	40.7a	84.8a	2.8a	4.8a	12.4a
500	46.5a(14.3)	103.8b (22.4)	3.1b(10.1)	5.8ab(21.1)	17.0b(37.7)
1000	48.7a(19.8)	108.3b (27.7)	3.2b(13.0)	5.8ab(21.1)	21.3c(72.6)
1500	52.1b (28.1)	114.3c (34.8)	3.5b(23.2)	6.0c(26.3)	24.2c(96.0)
2000	55.0b (35.2)	118.3d(39.5)	3.7b(31.6)	6.3c(31.6)	19.5b(57.5)

Means in the same column with the same letter (s) are not significantly different from one another at p=0.05

3.6. Effects of different rates of poultry manure on leaf, stem, shoot and root fresh and dry weight and total plant dry weight on pepper

The effect of different rates of poultry manure (PM) on leaf, stem, and shoot fresh and dry weight and root weight were found to be statistically different at 5% level of significance (Table 6).The results indicated that shoot dry weight differed significantly with the application of different rates of PM. There was an increase of 312.2, 382 and 392.8% for PM at rates of 10, 15 and 20t/ha respectively compared to the control (Table 6). For root dry weight, the increase was 97.1, 70.6 and 108.8% for 10, 15 and 20% compared to the control. Similarly, total plant dry weight increased by 269.9, 320.8 and 337.0% as PM increased from 10, 15 and 20t/ha respectively.

Table 6: Combined effects of poultry manure amended soils and irrigation levels on leaf, stem, shoot and root fresh and dry weight of pepper

Poultry manure (t/ha)	Irrigation levels (ml)	Leaf fresh weight (g)	Leaf dry weight (g)	Stem fresh weight (g)	Stem dry weight (g)	Shoot dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Shoot/ root ratio	Total plant dry weight (g)
0	250	14.1	1.9	8.0	1.6	2.2	2.5	0.6	1.3	4.1
	500	11.7	1.2	7.0	1.3	2.5	3.6	0.6	2.5	3.1
	1000	8.9	0.7	4.9	0.7	3.4	4.1	0.5	2.1	1.9
	1500	10.5	1.4	7.4	1.6	3.5	4.5	0.9	3.3	3.9
	2000	10.7	1.1	6.6	1.2	2.3	4.2	0.6	3.0	2.9
	Mean	11.2	1.38	6.8	1.28	2.78	3.8	0.68	4.1	3.46
10	250	22.8	3.7	17.6	3.1	7.6	2.7	0.7	3.0	7.5
	500	42.8	4.8	38.2	5.4	10.2	3.9	1.0	7.0	112
	1000	33.6	4.2	26.5	4.9	11.1	4.2	0.8	4.3	10
	1500	38.7	4.1	33.1	4.9	13	4.2	0.9	4.3	8.8
	2000	53.9	6.7	57.2	8.7	15.4	5.7	1.3	4.4	16.7
	Mean	36.4(225)	5.3(38.5)	35(415)	6.16(382.0)	11.46(312.2)	4.14(9.0)	1.34(97.1)	9.2(124.4)	12.8(270)
15	250	27.2	4.1	28.1	4.0	8.9	3.7	0.7	4.1	8.8
	500	45.3	6.3	40.5	6.6	12.9	6.0	1.0	7.4	13.9
	1000	36.9	4.8	35.9	5.4	14	4.7	0.9	5.6	11.1
	1500	47.5	6.4	45.6	7.2	15.3	4.9	1.2	6.0	14.8
	2000	56.1	7.0	58.0	8.9	15.9	6.0	1.5	7.0	17.4
	Mean	43.0 (284)	6.23(351.4)	42.0(518)	7.08(453.0)	13.4(382)	5.1(34.2)	1.16(70.6)	11.8(188)	14.56(321)
20	250	40.8	4.8	39.8	5.3	10.1	5.2	1.1	4.4	11.2
	500	51.3	7.3	47.5	7.7	15	6.0	1.3	6.7	16.3
	1000	51.8	6.5	46.8	6.8	13.3	8.8	1.5	5.2	14.8
	1500	55.6	6.8	50.8	8.3	15.1	5.5	1.3	8.0	16.4
	2000	59.2	7.0	58.5	9.1	15	6.0	1.6	7.5	17.7
	Mean	52.0(364.3)	6.48(370)	58.04(754)	7.22(464.1)	13.7(392)	6.3(65.8)	1.42(109)	9.7(136.6)	15.12(337)
PM		**	**	**	**	Ns	*	**	**	*
IL		**	**	**	**	Ns	*	*	*	**
										*
PM X IL		**	**	**	**	*	**	**	ns	

**P<0.01; *P<0.05; ns = Non-significant PM: Poultry manure IL: Irrigation levels.

3.7. Effects of different irrigation levels on leaf, stem, shoot and root fresh and dry weight, and total plant dry weight on pepper

There were significant effect of different irrigation levels on shoot fresh and dry weight, root dry weight and total plant dry weight (Table 7). Among the different levels of treatment 1500ml-2000ml/plant responded the highest in all the PM rates applied to the soil. There was a percentage increment in shoot dry weight as the irrigation levels increased. An increase of 41, 45.1, 62.8 and 68.8% was observed as irrigation levels increased at 500, 1000, 1500 and 2000ml/plant compared to the least amount (250ml/plant). With regards to root dry weight, a percentage increase of 25.8, 67.7, 87.1 and 61.3% was observed for 500, 1000, 1500 and 2000ml/plant compared to the least level of 250ml/plant. A significant percentage change of 39.5, 47.3, 65.2 and 68.0 in total plant dry weight was observed when plants were supplied with 500, 1000, 1500 and 2000mls/plant respectively compared to treatments that received 250ml/plant to the different rates of PM (Table 7).

Table 7: Mean effects of different irrigation levels on shoot, root and total plant dry weight

Irrigation levels	Shoot dry weight (g)	Root dry weight (g)	Total plant dry weight (g)
250	7.2a	0.775a	7.975a
500	10.15b(41.0)	0.975a(25.8)	11.125b(39.5)
1000	10.45b(45.1)	1.3b(67.7)	11.75a (47.3)
1500	11.725b(62.8)	1.45c (87.1)	13.175c(65.2)
2000	12.15c (68.8)	1.25bc(61.3)	13.4c(68.0)

Means in the same column with the same letter (s) are not significantly different from one another at p=0.05

3.8. Effect of different rates of poultry manure on NAR, LAR, LWR and SLA

Effect of different rates of poultry manure (PM) on NAR, and LWR were found to be statistically different at 5% level of significance (Table 8). The results indicated that RGR and NAR differed significantly with the application of different rates of PM. There was a percent increase of 26.5, 41.1 and 24.4% in RGR for increasing Pm at the rates of 10, 15, and 20t/ha respectively. In terms of NAR, there was a percent increase of 21.86, 28.74 and 38.72% for 10, 15 and 20t/ha compared to the control. A significant change of -54, -48.4 and -56 in LAR was observed when plants were supplied with PM rates 10, 15 and 20t/ha as compared to the control plots respectively. Similarly, there was a percent increase of 10.00, 14.21, and 13.16% in LWR when plants were supplied with PM rates 10, 15 and 20t/ha as compared to the control treatment. Data in Table 8 again indicate that there was a percent increase of -57, 52.1 and -59% in SLA when plants were supplied at PM rates of 10, 15 and 20t/ha over the control treatment.

Table 8: Combined effects of poultry manure amended soils and irrigation levels on NAR, LAR, LWR, SLA and RWC of pepper

Poultry manure (t/ha)	Irrigation levels (ml)	RGR ($g{\cdot}g^{-1}{\cdot}day^{-1}$)	NAR ($g{\cdot}m^{-2}{\cdot}day^{-1}$)	LAR ($cm^2{\cdot}g^{-1}$)	LWR ($g{\cdot}g^{-1}$)	SLA ($cm^2{\cdot}g^{-1}$)	RWC (%)
0	250	0.04	3.55	3.0	0.36	8.4	86.0
	500	0.37	5.55	3.2	0.39	8.3	117.2
	1000	1.07	4.34	2.4	0.41	5.8	96.6
	1500	1.34	4.8	2.7	0.43	6.3	94.8
	2000	1.56	3.4	3.9	0.38	10.2	146.0
	Mean	**0.876**	***4.328***	***3.1***	***0.38***	***7.8***	***540.6***
10	250	0.07	4.22	1.1	0.45	2.5	82.1
	500	1.1	5.5	1.3	0.43	2.9	71.0
	1000	1.4	5.96	1.3	0.40	3.2	88.0
	1500	1.54	6.67	1.7	0.41	4.2	70.7
	2000	1.3	4.02	1.6	0.40	4.0	79.1
	Mean	***1.082 (26.5)***	***5.274(21.9)***	***1.4 (-55)***	***0.418(10)***	***3.36(-57)***	***327.62(-39.4)***
15	250	0.06	4.59	1.6	0.43	3.8	89.1
	500	1.2	5.4	1.6	0.45	3.4	325.0
	1000	1.5	6.83	1.7	0.45	3.7	102.5
	1500	1.63	6.02	1.8	0.44	4.0	125.3
	2000	1.45	5.02	1.5	0.40	3.8	115.0
	Mean	**1.168 (41.1)**	***5.572(28.74)***	***1.64 (-47.1)***	***0.434(14.2)***	***3.74(-52.1)***	***151.38(-78)***
20	250	0.07	4.91	1.2	0.43	2.8	89.0
	500	1.13	5.82	1.4	0.45	3.1	138.2
	1000	1.3	6.71	1.8	0.44	4.0	88.4
	1500	1.23	6.98	1.3	0.41	3.2	89.5
	2000	1.2	5.6	1.1	0.42	2.7	241.0
	Mean	**0.986(24.4)**	***6.004(38.72)***	***1.36(-56)***	***0.43(13.2)***	***3.16(-59)***	***129.22(-76.1)***
PM		*	*	Ns	ns	Ns	ns
IL		*	*	ns	ns	Ns	ns
PM X IL		ns	ns	ns	ns	Ns	ns

**P<0.01; *P<0.05; ns ═ Non-significant PM: Poultry manure IL: Irrigation levels.

3.9. Mean effects of different irrigation levels on NAR, LAR, LWR, SLA and RWC

There were significant effect of different irrigation levels on RGR, NAR, LAR, LWR and SLA (Table 9). There was a percent increase in RGR and NAR as the irrigation levels increased. An increase of 192, 305.4, 341.5 and 323.8% in RGR was observed as watering regimes increased from 500, 1000, 1500 and 2000ml/plant while an increase of 38.04, 41.69 and 29.70% was observed in NAR as irrigation levels increased at 500, 1000, 1500 and 2000mL/plant compared to the least amount (250mL/plant). With regards to LAR a percent increase of 8.70, 4.35, 13.04 and 17.39% was observed for 500, 1000, 1500 and 2000mL/plant compared to the least level of 250mL/plant. Similar numerical values (2.99) were observed in the percent increase for LWR when plants were supplied with 500, 1000, 1500 and 2000mLs/plant respectively compared to the treatments that received 250mL/plant to the different rates of PM (Table 9). An increase of 0.11, -4.6, 1.14 and 18.3% was observed in SLA as irrigation levels increased at 500, 1000, 1500 and 2000mL/plant compared to the least amount (250mL/plant). With regards to the RWC, a percentage increase of 88.2, 8.5, 9.9 and 0.7% was observed as the irrigation levels increased from 500, 1000, 1500 and 2000mLs/plant compared to the least level of 250mL/plant.

Table 9: Mean effects of irrigation levels on NAR, LAR, LWR and SLA of pepper

Irrigation levels (ml)	RGR ($g \cdot g^{-1} \cdot day^{-1}$)	NAR ($g \cdot m^{-2} \cdot day^{-1}$)	LAR ($cm^2 \cdot g^{-1}$)	LWR ($g \cdot g^{-1}$)	SLA ($cm^2 \cdot g^{-1}$)	RWC (%)
250	0.325a	4.32a	1.73a	0.42a	4.36a	86.6a
500	0.95a(192.0)	5.57ab(28.95)	1.88a(8.70)	0.43a(2.99)	4.43a(0.11)	92.9b(88.2)
1000	1.32b (305.4)	5.96ab(38.04)	1.80a(4.35)	0.43a(2.99)	4.58a (0.2)	93.9b (8.5)
1500	1.44b (341.5)	6.12b(41.69)	1.95b(13.0)	0.43a(2.99)	4.53a(0.05)	95.1b (9.9)
2000	1.38b(323.8)	5.60ab(29.70)	2.03b(17.4)	0.43a(2.99)	5.18b(18.3)	145.3c (0.7)

Means in the same column with the same letter (s) are not significantly different from one another at P = 0.05

3.10. Mean effects of different rates of poultry manure on chlorophyll a & b, leaf and root proline

The effects of different rates of poultry manure (PM) on chlorophyll *a* and *b*, proline leaf and root were found to be statistically different at 5% level of significance (Table 10).The results indicated that chlorophyll *a* content differed significantly with the application of different rates of PM. There was a percent increase of 3.4, 1.4 and -2.7% for PM at rates of 10, 15 and 20t/ha respectively to the control (Table 10). With regards to chlorophyll *b* content, the increase was 12, 10.5 and 4.5% for 10, 15 and 20t/ha compared to the control. Similarly proline leaf increased by 103, 1 and 4.5% as PM increased from 10, 15 and 20t/ha respectively. In term of proline root, an increase of -44, -41 and -54% was observed as PM increased from 10, 15 and 20t/ha respectively.

Table 10: Combined effect of poultry manure amended soils and irrigation levels on chlorophyll content and leaf and root proline of pepper

Poultry manure (t/ha)	Irrigation levels (mL)	Chlorophyll a (mg g^{-1} fw)	Chlorophyll *b* (mg g^{-1} fw)	Leaf proline (µmol g^{-1} fw)	Root proline (µmol g^{-1} fw)
0	250	0.082	0.485	0.298	0.522
	500	0.180	0.633	0.211	0.356
	1000	0.107	0.619	0.217	0.401
	1500	0.181	0.714	0.289	0.405
	2000	0.190	0.525	0.185	0.553
	Mean	***0.148***	***0.600***	***0.240***	***0.450***
10	250	0.188	0.259	0.258	0.293
	500	0.122	0.747	0.184	0.203
	1000	0.148	0.759	0.251	0.209
	1500	0.150	0.790	0.289	0.262
	2000	0.156	0.805	0.307	0.271
	Mean	***0.153(3.4)***	***0.672(12)***	***0.257(7.1)***	***0.248(-44)***
15	250	0.147	0.439	0.278	0.293
	500	0.139	0.769	0.230	0.141
	1000	0.180	0.603	0.172	0.239
	1500	0.182	0.720	0.273	0.304
	2000	0.102	0.782	0.256	0.347
	Mean	***0.15(1.4)***	***0.663(10.5)***	***0.242(1)***	***0.265(-41)***
20	250	0.139	0.680	0.216	0.279
	500	0.159	0.800	0.209	0.128
	1000	0.161	0.775	0.205	0.166
	1500	0.142	0.142	0.212	0.162
	2000	0.121	0.737	0.441	0.297
	Mean	***0.144(-2.7)***	***0.627(4.5)***	***0.257(7.1)***	***0.2064(-54)***
PM		*	**	ns	*
IL		*	*	**	*
PM X IL		*	*	*	*

**P<0.01; *P<0.05; ns = Non-significant PM: Poultry manure IL: Irrigation levels.

3.11. Mean effects of different irrigation levels on chlorophyll a & b, leaf and root proline on pepper

There were significant effects of different irrigation levels on chlorophyll *a*& b, leaf and root proline (Table 11). There was a percent increment in chlorophyll *a* content as the irrigation levels increased. An increase of 8, 7.3, 18.1 and 2.5% was observed as irrigation levels increased at 500, 1000, 1500 and 200mL/plant compared to the least amount of (250mL/plant). With regards to chlorophyll *b* content, a percentage increase of 58.8, 48.1, 27 and 58.9 was observed when plants were supplied with 500, 1000, 1500 and 2000mLs/plant respectively compared to treatments that received 250mL/plant to different rates of PM (Table 11). The data also indicate that there was a percent increase of -62, -61, -52 and -46% for leaf proline when plants were supplied with 500, 1000, 1500 and 2000mLs/plant compared to treatments that received 250mL/plant. A significant percentage change of -40.3, -26.8, -18.3 and 5.8 in root proline was detected when plants were supplied with irrigation levels 500, 1000, 1500 and 2000mLs/plant respectively compared to treatments that received 250mL/plant to different rates of PM (Table 11).

Table 11: Mean effects of irrigation levels on chlorophyll, leaf and root proline contents

Irrigation	**Chlorophyll a**(mg g^{-1} fw)	**Chlorophyll b**(mg g^{-1} fw)	**Leaf Proline** (µmol g^{-1} fw)	**Root proline** (µmol g^{-1} fw)
250	0.14a	0.47a	2.19b	1.39c
500	0.15a(8.0)	0.74b(58.8)	0.83a(-62.0)	0.83a(-40.3)
1000	0.15a(7.3)	0.69b(48.1)	0.85a(-61.5)	1.02b(-26.8)
1500	0.16a(18.1)	0.59a(27.0)	1.06a(-52.0)	1.13b(-18.3)
2000	0.14a(2.5)	0.71b(58.9)	1.19b(-46.0)	1.14b(-18.6)

Means in the same column with the same letter (s) are not significantly different from one another at P = 0.05

3.12. Mean effects of different rates poultry manure on root length and canopy diameter

The effect of different rates of poultry manure (PM) on root length, canopy diameter and relative growth were found to be statistically different at 5% level of significant (Table 12). The results indicated that root length differed significantly with the application of different rates of PM.

There was a percentage increase of -17.4,-10.3 and 4.84% for 10, 15 and 20t/ha compared to control plots. With regards to canopy diameter, the increase was 106.7, 80.4 and 112.4% as PM increased from 10, 15 and 20t/ha respectively. The effect of different rates of poultry manure (PM) on pericarp thickness and pendicle length were found to be non significant at the 5% level of significance.

3.13. Mean effects of different irrigation levels on root length and canopy diameter

There was a percentage increment in root length as the irrigation levels increased. An increase of -31, -39.6, -17.6, and -25.8% at 500, 1000, 1500 and 2000mL/plant respectively was observed (Table 13).

With regards to canopy diameter, a percentage increase of -76.7, -92.3, -76 and -70% was observed for 500, 1000, 1500 and 2000mL/plant as compared to the least level of 250mL/plant (Table 13).

Table 12: Combined effects of different rates of poultry manure and irrigation levels on root length (cm), canopy diameter (cm) and relative growth rate (g.g^{-1}. day^{-1})

Poultry manure (t/ha)	Irrigation levels	Root length	Canopy diameter
0	250	12.0	18.2
	500	7.1	17.8
	1000	8.6	15.7
	1500	12.9	18.0
	2000	9.0	17.4
	Mean	***9.92***	***17.42***
10	250	7.1	40.2
	500	7.1	33.4
	1000	8.4	34.4
	1500	10.0	28.0
	2000	8.5	44.0
	Mean	***8.22(-17.14)***	***36(106.7)***
15	250	11.4	30.2
	500	10.1	29.4
	1000	6.0	25.5
	1500	7.0	28.0
	2000	10.0	44.0
	Mean	***8.9(-10.3)***	***31.42(80.4)***
20	250	18.0	31.5
	500	9.4	31.0
	1000	6.3	41.2
	1500	10.0	41.0
	2000	8.3	39.0
	Mean	***10.4(4.84)***	***37(112.4)***
PM		**	**
IL		*	*
PM X IL		*	*

**P<0.01; *P<0.05; ns = Non-significant PM: Poultry manure IL: Irrigation levels.

Table 13: Mean effects of different irrigation levels on root length (cm), canopy diameter (cm) and relative growth rate ($g.g^{-1}.\ day^{-1}$) on pepper

Irrigation levels	Root length	Canopy diameter
250	7.23a	12.0a
500	8.43a(-31)	28b(-76.7)
1000	9.33a(-39.6)	29.2b(-92.3)
1500	10b(-17.6)	28.8b (-76)
2000	9.5ab(-25.8)	36.1c(-70)

Means in the same column with the same letter (s) are not significantly different from one another at P = 0.05

Table 14: Combined effects of different rates of poultry manure yield and yield components

Poultry manure (t/ha)	Irrigation levels	No/fruits	Ave. fruit weight(g/fruit)	Fruit wt/plant	Yield (kg/plant)	Yield (t/ha)
0	250	33	2.0	66	2357.1	2.36
	500	40	2.2	88	3142.8	3.14
	1000	45	2.3	103.5	3696.4	3.70
	1500	46	2.4	110.4	3942.8	3.94
	2000	45	2.3	103.5	3693.4	3.70
	Mean	**41.8**	**2.44**	**94.28**	**3367.1**	**3.37**
10	250	40	2.4	96	3428.5	3.43
	500	50	2.5	125	4464.3	4.46
	1000	55	2.6	143	5107.1	5.11
	1500	60	2.2	132	4714.2	4.71
	2000	55	2.4	132	4714.2	4.71
	Mean	**52 (24.4)**	**2.42(-1)**	**125.6(33.2)**	**4485.7(33.2)**	**4.49(33.2)**
15	250	50	3	150	5357.1	5.36
	500	56	2.4	134.4	4800.0	4.80
	1000	64	2.3	147.2	5257.1	5.26
	1500	69	2.8	193.2	6899.9	6.90
	2000	50	2.1	105	3745.0	3.75
	Mean	**57.8(46)**	**2.52(3.3)**	**145.96(55)**	**5212.8(55)**	**5.21(55)**
20	250	53	2.5	133	4732.1	4.73
	500	55	2.1	116	4125.0	4.12
	1000	65	2.4	156	5571.4	5.57
	1500	66	2.5	132	4714.2	4.71
	2000	60	2.2	132	4714.2	4.71
	Mean	**59.8(51)**	2.34(-8.2)	**133.6(42)**	**4771.4(42)**	**4.77(46)**
PM		*	ns	*	*	*
IL		*	ns	*	ns	*
PM X IL		*	ns	*	*	*

**P<0.01; *P<0.05; ns = Non-significant PM: Poultry manure IL: Irrigation levels.

3.14. Effects of different rates of poultry manure on number of flower, fruits and yield per hectare

The effects of different rates of poultry manure (PM) on yield and yield components were found to be statistically different at 5% level of significance (Table 14). Fruit number per plant increased as PM rate increased. The increase was 31.3, 46 and 51% for 10, 15 and 20t/ha respectively compared to the control (Table 14). The effect of different rates of poultry manure (PM) on fruit weight and yield (t/ha) were found to be significant at the 5% level of significance. A percentage increase of 33.2, 55 and 46% was observed as PM increased from 10, 15 to 20t/ha compared to the control.

3.15. Mean effects of different irrigation levels on number of flower, fruit number and weight and yield per hectare

There were significant effect of different irrigation levels on fruit number and fruit weight and yield per hectare (Table 15). Fruit number increased with increased application of water and a percentage increase of 22.6, 39, 47 and 34.1% was observed for 500, 1000, 1500 and 2000mL/plant compared to the least level of 250mL/plant. A significant percentage change of 22.01, 30.7, 37.1 and 17.5 in fruit weight was detected when plants were supplied with 500, 1000, 1500 and 2000mLs/plant respectively compared to treatments that received 250mL/plant to the different rates of PM (Table 15). A similar trend was recorded for yield per hectare.

Table 15: Mean effects of different irrigation levels on number of flower, fruit number and weight and yield per hectare

Irrigation levels	Number of flower	Fruit number	Fruit weight	Yield (t/ha)
250	13.0a	41.0a	90.8a	3.24a
500	16.3b(25.4)	50.3b(22.6)	110.7b(22.01)	3.51b(8.1)
1000	19.3b(-28.5)	57.0b(39.0)	118.6b(30.7)	4.24c(30.7)
1500	19.3b(-28.5)	60.3c(47.0)	124.4c(37.1)	4.46c(37.4)
2000	16.0b(23.1)	55.0b(34.1)	106.6b(17.5)	3.81b(17.5)

Means in the same column with the same letter (s) are not significantly different from one another at P = 0.05

4. Discussion

4.1. Effect of soil amendments on some physical and chemical properties of soil

The clay loam soils used in the experiment was slightly acidic, low in organic matter (O.M), total N, available P and Exchangeable Ca. In the present study (Table 4), it was found that poultry manure amendments at 10, 15 and 20 t ha-1 increased soil O.C, total P, available P, pH and cation exchange capacity than the control (only soil). Reference [1] had found that application of poultry manure to soil increased soil organic matter, N and P and aggregate stability. The values of SOC and N tended to increase with increased level of manure.

Poultry manure additions up to 10, 15 and 20 t ha-1in the present study improved soil physical properties as indicated by reduction in soil bulk density and increased in the pH (Table 4). Application of poultry manure and other farm wastes have been found to increase the carbon content, water holding capacity, aggregation of the soil and a decrease in the bulk density. In addition, Incorporation of organic matter such as poultry manure increased the fertility status [53]. The present studies confirmed that soil acidity is decreased with the application of manure. It can therefore be deduced that the amendments increased the pH from 5.1 initial to (6.7, 6.5, and 6.8) might be due to the increased organic matter content of the soils, confirming [30], who reported that, organic matter is a reservoir of plant nutrients, has high cation exchange capacity and buffers the soil against pH changes. The decrease in bulk density of the amendments soil might be linked with the increase in organic matter content of the soil.

4.2. Effect of poultry manure on growth of pepper

The results of the studies showed conclusively that the soil amendments gave significantly higher plant height, number of leaves and stem girth than the control as the rate of poultry manure increases (Table 5). The increase in plant height positively affected other parameters measured, such as root length, number of leaves, stem girth and canopy diameter when poultry manure was supplied.

The positive response of pepper to manure in this study has also been shown for other crops such as cucumber and tomato [14], grape [10] and vegetable marrow (*Curcurbitapepo*) [36]. Significant differences in growth rate observed between pepper with amendment (poultry manure) interaction with water stress and those of the control (only soil) could be explained mainly in terms of differences in organic matter between the manure interaction with irrigation regimes and the control. The values reported for soil pH before the experiment was slighty acidic (5.1) but the application of poultry manure slightly increased the control pH (5.5) twelve weeks after transplanting resulting in improved vegetative growth of the pepper. This could be due to the fact that poultry manure was rich in K, Ca and Mg which created a liming effect in soil and stability of the soil buffering capacity. The observation agreed with the work of [24, 33]. Soil pH had been reported to influence nutrient availability and uptake by crops [2].

The significant increase in number of leaves recorded between poultry manure interaction with irrigation regime compared to the control might be due to high Total K, Total P and nitrogen presence in the poultry manure. According to [55], adequate amounts of nitrogen may be obtained from reasonable amounts of organic matter applied to the soil is directly responsible for vegetative growth of plants. The increase in poultry manure rate increased the number of leaves, plant height, number of leaves and stem girth (Table 5). This could be attributed to improved soil conditions (moisture retention, soil structure and aeration and increase nitrogen availability) following the poultry manure application. Nitrogen is known to enhance physiological activities in crops thereby improving the synthesis of photo-assimilates [8]. Nitrogen is an important constituent in pepper metabolises and chlorophyll necessary for promoting aerial growth, increase tap-root ratio, leaf area, number of branches and height [39].

4.3. Effect of water stress on growth of pepper

There were no significant differences in plant height between poultry manure 15 and 20 t/ha interactions with irrigation regimes 1000, 1500 and 2000 mL (Table 6). However, the highest numerical mean in plant height, number of leaves and stem girth were detected between poultry manure 20t/ha interaction irrigations regimes 2000mL (64.04cm, 156 and 4.36mm). The least mean in plant height, number of leaves and stem girth were detected between poultry manure 0t/ha interaction with irrigation regime 250mL (30.37cm, 56 and 1.90mm). This study agrees with the finding of [42] reported that water stress results in reduction in growth of most growth parameters in plants. Reference [3, 4] reported that the water stress caused major reductions in height, leaf number, leaf area index, fresh and dry weight of cotton plants and some *Cucurbitaceae* members. With an increase in water stress, the rate of photosynthesis decreases rapidly.

From the results of leaf area measurements (13.43, 9.910, 9.94, 7.875, and 11.22 cm^2) leaf area were significantly affected this can be seen by the reduction in leaf area between poultry manure 0t/ha interactions with irrigation regimes 250mL to 2000mL (Table 6). Similar finding was found by [19] who related the reduction in leaf area and plant size to water stress. The table shows that the highest numerical mean leaf area was observed between poultry manure 0t/ha interaction with irrigation regime 250mL (36.09cm^2)while the least leaf area was detected between poultry manure 0t/ha interaction with irrigation regime 1500mL (7.875cm^2). This finding contradicts the finding of [35] documented that reduction of moisture reduces the rate of leaf expansion. However, the amendments used in the studies could be a factor for the increase in leaf area mainly at poultry manure 10t/ha application.

Table 11 shows the leaf chlorophyll (*a* & *b*) content. The study shows that there were no significant differences in chlorophyll *a* between poultry manure 0t/ha to 20t/ha interactions with irrigation regimes 250mL to 2000mL. A difference in chlorophyll *b* was observed in Table 8. This implies that chlorophyll content (*a* & *b*) were low. This finding is in concurrence with the finding of [40] who reported that leaf chlorophyll content decreases as a result of water stress. Water stress caused a large decline in the chlorophyll *a* content, the chlorophyll *b* content in sunflower varieties investigated by [31]. The decrease in chlorophyll under water stress is mainly the result of damage to chloroplasts caused by active oxygen species [49]. It can be deduced that water stress (excess water and water deficit) significantly decreases leaf chlorophyll (chlorophyll *a, b*) concentrations.

The highest numerical mean for the root proline was observed between poultry manure 20t/ha interaction with irrigation regime 500mL (0.5983 *u* mol g^{-1} fw). In addition, poultry manure 10t/ha interaction with irrigation regime 250mL had the highest numerical mean for proline leave (1.4024 *u* mol g^{-1} fw). More proline accumulation in response to stress was observed in leaves than in root, in agreement to earlier observations [9, 48]. Reference [44] also observed higher proline levels in leaves than in roots of oil seed rape plants (Table 10). The fact that plant develop more proline accumulation in response to water stress is evidence by the findings of [46, 6] documented that the proline content increased under water stress in pea (Table 11). The accumulation of proline in plant tissues is also a clear marker for environmental stress, particularly in plants under water stress [45].

In this study the longest root length was observed between poultry manure 20t/ha interaction with irrigation regime 250mL (17.64cm). The volume of the water was limited thereby causing roots of unwatered plants to grow deeper into the soil than roots of plants that were watered regularly. This is in agreement with the finding of [43]. The longest canopy diameter was detected between poultry manure 10t/ha interaction with irrigation regime 1500mL and 2000mL (44.500cm and 43.900cm). The shortest canopy was observed between poultry manure 0t/ha interaction with irrigation regime 1000mL (15.700cm). Photosynthesis is directly correlated to root growth and canopy diameter under water stress conditions photosynthesis becomes limited an increased in root length showed that root length increase as a defense mechanism of the plant to deal with water stress conditions [5].

There highest numerical mean root shoot ratio was observed between poultry manure 20t/ha interactions with irrigation regimes 1500 and 2000 mL (7.800 and 7.480), respectively (Table 7). However, the least mean root shoot was detected between poultry manure 0t/ha interaction with irrigation regime 250mL (1.260). There were no significant differences in the Net Assimilation Rate (NAR). But a numerical increase in NAR occurred between poultry manure 0t/ha interaction with irrigation regime 500mL (5.546). The finding indicated that water shortage significantly affects extension growth and the root-shoot ratio at the whole plant level. Moreover, plant growth rates are generally reduced when soil water supply is limited [52].

4.4. Effect of poultry manure on yield and yield component of pepper

Table 15 contains data on number of flower and number of fruits. The highest numerical mean in number of fruits was observed between poultry manure 20t/ha interaction with irrigation regime 1000mL (14.333). The result shows that among the amendments (Pm 10, Pm15 and 20 t/ha), Pm20t/ha was the highest rate applied. This finding contradicts the finding by [8] that excess nitrogen application reduced number of fruits and yield. Moreover, our finding also detected that the next numerical increase in number of fruits was between poultry manure 15t/ha interaction with irrigation regime (13.333). Application of poultry manure resulted in increase number of fruits per plant, longer fruits and pendicle length. This could be attributed to the fact that the poultry manure supplied essential nutrients for enhanced productivity [26, 15].

4.5. Effect of water stress on yield and yield component of pepper

There were no significant differences in number of flower between poultry manure 10 to 20 t/ha interactions with irrigation regimes 250 to 1500 mL (Table 15). Differences were observed between poultry manure 15 and 20 t/ha interaction with irrigation regime 2000mL (24.00 and 24.667) respectively. The blossom stage of hot pepper is considered the most susceptible period to water stress [12]. For high yields, an adequate water supply and relatively moist soils are required during the total growing period. Reduction in water supply during the growing period in general has an undesirable affection yield, and the greatest reduction in yield occurs when there is a continuous water shortage until the time of fruit harvesting. The period at the beginning of the flowering period is the most sensitive to water shortage, and soil water depletion in the root zone during this period should not exceed 25% [16].

Water stress just prior and during early flowering reduces the number of fruits. On hot pepper (Legon 18), water stress during the vegetative and fruiting stages decrease the yield (Table 15). Similar results were obtained by [18, 29, 28] in pepper, sweet pepper and hot pepper reporting a consequently yield decrease under stress conditions. It can be seen from Table-15 that Pm 20t/ha interaction with irrigation regime 100mL produced the highest numerical mean of fruits (14.333) followed by Pm15 t/ha interaction with irrigation regime 250ml (13.333) fruits, then 15t/ha interaction with irrigation regimes 1500 and 2000 mL (12.33 and 12.33) respectively, and lastly 20t/ha interaction with irrigation regime 1500mL (10.333). According to [21] in an experiment conducted, highest yields were obtained from highest regulated irrigation regime and lowest yield was obtained from the lowest irrigation water applied. [22] also establish that deficit irrigation significantly affected the fruit numbers, fruit dry weight and dry yield of hot pepper; the average fruit numbers increased over 3 times with non-stressed compared to water stressed treatments.

5. Conclusions

In general, the results showed that there was significant effect of irrigation levels on biometric

parameters such as plant height, fresh weight, stem diameter, branches number, number of leaves, leaf area per plant in combination with poultry manure treatments and interaction effect . The study also showed significant effect of irrigation levels on secondary response variables such as relative growth rate, net assimilation rate, leaf area ratio, specific leaf area and leaf weight ration as well as yield and its components in combination with poultry manure treatments. Interaction effect of poultry manure and irrigation levels was significant.

The study indicated that organic matter increased with the application of poultry manure which also improved the soil physical and chemical properties including ph, exchangeable cations.

Poultry manure at higher rates (15-20t/ha) and in combination with irrigation levels at 1000 – 1500mls increased plant height, number of leaves, shoot fresh and dry weights as well as total plant dry weight and leaf area. At low water levels plant growth was reduced.

Poultry manure at 15-20t/ha and irrigation levels of 1000-1500mls increased the photosynthetic efficiency (NAR), dry matter accumulation (LAR) and dry matter partitioning (LWR). Water levels at lower levels reduced physiological activities.

The study further revealed that poultry manure at 15t/ha and irrigation levels of 1000 -1500mls increased yield and low levels of poultry manure and water applications resulted in low yields.

Proline content in pepper plants were found to be higher at low water stress and poultry manure levels.

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